NAME: _____

Score: _____ / + 20

Chemistry 312
Final Review

**FINAL EXAM**
***Review Problems***

1. Name the following molecules.
   a. $H_2SO_4$ Sulfuric acid
   b. $CuNO_3$ Copper I nitrate
   c. AgCl Silver Chloride
   d. $Ca(OH)_2$ Calcium hydroxide
2. Write the formulas for the following compounds.
   a. hydrofluoric acid HF
   b. iron (III) oxide $Fe_2O_3$
   c. ammonium phosphate $(NH_4)_3PO_4$
   d. aluminum chloride $AlCl_3$
3. Balance and identify the type of reaction for the following.
   a. ____ $I_2$ + 2 NaF → 2 NaI + ____ $F_2$ (single replacement) This actually does not occur
   b. ____ KOH + ____ $AgNO_3$ → ____ $KNO_3$ + ____ AgOH Double replacement
   c. ____ $C_3H_8$ + 5 $O_2$ → 3 $CO_2$ + 4 $H_2O$ Combustion
   d. 3 $H_2$ + ____ $N_2$ → 2 $NH_3$ Synthesis
   e. ____ $(NH_4)_2SO_4$ → 2 $NH_3$ + ____ $H_2SO_4$ Decomposition
4. Predict the products and then balance the equations.
   a. ____ $CH_4$ + 2 $O_2$ → $CO_2 + 2H_2O$
   b. ____ Al + ____ $Pb(NO_3)_3$ → $Pb + Al(NO_3)_3$
   c. ____ $Ca(OH)_2$ + 2 HCl → $CaCl_2 + 2H_2O$ Remember $HOH = H_2O$
   d. ____ $PbO_2$ → $Pb + O_2$
   e. 2 Na + ____ $Cl_2$ → 2NaCl
5. Will any of the above reactions form a precipitate? If so, which ones? NO.
   ↳ By definition a precipitate is a solid that arises when two aqueous solutions are combined.
6. Will the following reactions occur?
   a. $Cl_2 + LiI$ → $LiCl + I_2$ yes (not balanced)
   b. $Ag + Cu(NO_3)_2$ → NR (silver is lower on the activity series than copper)
7. Calculate the number of molecules in 87 grams of hydrochloric acid.

$$87\text{g HCl}\left(\frac{1\text{mole}}{36.5\text{g}}\right)\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}}\right) =$$

$1.4\times10^{24}$ molecules HCl

8. Calculate the number of grams of $KClO_3$ in $1.26\times10^{37}$ molecules of the compound.

$$1.26\times10^{27}\text{ molecules}\left(\frac{1\text{mol}}{6.02\times10^{23}\text{ molecules}}\right)\left(\frac{122.6\text{g}}{1\text{ mol}}\right) =$$

$2.57\times10^{5}$ g $KClO_3$

9. Calculate the number of moles in 49.98 grams of Bohrium.

$$49.98\text{g Bh}\left(\frac{1\text{mol}}{262\text{g}}\right) = 0.19\text{mol Bh}$$

0.19 mol Bh

10. Balance the equation and then use the reaction to answer the following questions.

$$\underline{2}\ NaCl_{(aq)} + \underline{\quad}\ H_2SO_{4(aq)} \rightarrow \underline{2}\ HCl_{(g)} + \underline{\quad}\ Na_2SO_{4(aq)}$$

(A: NaCl; B: HCl)

a. How many moles of hydrochloric acid would be produced if 3.65 moles of sodium chloride are used up?

$$3.65\text{mol A}\left(\frac{2\text{mol B}}{2\text{mol A}}\right) = 3.65\text{mol B (HCl)}$$

3.65 mol HCl

b. How many grams of sodium sulfate will be made when 72 grams of sulfuric acid react with an excess of sodium chloride? $2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2SO_4$ (A: $H_2SO_4$; B: $Na_2SO_4$)

$$72\text{g}\left(\frac{1\text{mol A}}{98.1\text{g}}\right)\left(\frac{1\text{mol B}}{1\text{mol A}}\right)\left(\frac{142.1\text{g}}{1\text{mol B}}\right) = 104\text{g Na}_2\text{SO}_4$$

104g $Na_2SO_4$

c. Determine the limiting reactant when 112 grams of sodium chloride react with 203 grams of sulfuric acid.

METHOD I - Compare moles

$112\text{g NaCl}\left(\frac{1\text{mol}}{58.5\text{g}}\right) = 1.9\text{ moles}$

$203\text{g H}_2\text{SO}_4\left(\frac{1\text{mol}}{98.1\text{g}}\right) = 2.1\text{ moles}$

| | Given | Equation |
|---|---|---|
| NaCl | 1.9 | 2 |
| $H_2SO_4$ | 2.1 | 1 |

NaCl limiting

METHOD II - Stoich

$1.12\text{g NaCl}\left(\frac{1\text{mol}}{58.5}\right)\left(\frac{2\text{mol HCl}}{2\text{mol NaCl}}\right) = 1.9\text{ mol HCl}$

$203\text{g H}_2\text{SO}_4\left(\frac{1\text{mol}}{98.1\text{g}}\right)\left(\frac{2\text{mol HCl}}{1\text{mol H}_2\text{SO}_4}\right) = 4.1\text{ mol HCl}$

1.12g NaCl yields the smaller amount of product.

11. Determine the percent yield in the reaction if one starts with 20 grams of potassium bromide and produces 5 grams of bromine gas.

$$2KBr + Cl_2 \rightarrow 2KCl + Br_2$$

(A: KBr; B: $Br_2$)

$$20\text{g KBr}\left(\frac{1\text{mol}}{119\text{g KBr}}\right)\left(\frac{1\text{mol B}}{2\text{mol A}}\right)\left(\frac{159.8\text{g}}{1\text{mol B}}\right) = 13.4\text{g}$$

$\frac{5}{13.4} \times 100 =$

37 %

12. Which diffuses at a faster rate: $SO_2$ or $NO_2$? What is the ratio of diffusion rates?

$NO_2$ is faster because of its smaller molar mass

$SO_2 = B$ $\quad NO_2 = A$ $\quad \frac{\text{ratio of } NO_2}{\text{ratio of } SO_2} = \sqrt{\frac{64.1g}{46g}} = 1.18$

$NO_2$ diffuses 1.18 times faster than $SO_2$

13. Determine the empirical formula for a compound with 36.5% Na, 25.4% S, and 38.1% O.

$36.5g\ Na\left(\frac{1mol}{23g}\right) = 1.587\ mol\ Na = 2$

$25.4g\ S\left(\frac{1mol}{32.1g}\right) = \frac{0.7913}{0.7913}\ mol\ S = 1$

$38.1g\ O\left(\frac{1mol}{16g}\right) = \frac{2.381}{0.7913}\ mol\ O = 4$

$Na_2SO_4$

14. Determine the molecular formula for a compound consisting of 56.4% P and 43.6% O with a molar mass of 220 g/mol.

$56.4g\ P\left(\frac{1mol}{31g}\right) = \frac{1.819}{1.819}\ mol\ P = 1mol\ P \times 2 = 2$ $\quad P_2O_3 = 110g$

$43.6g\ O\left(\frac{1mol}{16g}\right) = \frac{2.725}{1.819}\ mol\ O = 1.5mol\ O \times 2 = 3$ $\quad \frac{220}{110} = 2$

$P_{2\times2}O_{3\times2}$

$P_4O_6$

15. Use Boyle's, Charles's, or Gay-Lussac's law to calculate the missing value in each.

a.

$V_1 = 3.1$ L $\quad P_1 = ?$ $\quad V_2 = 6.7$ L $\quad P_2 = 2.04$ atm

$P_1V_1 = P_2V_2$

$P_1 = \frac{P_2V_2}{V_1}$

$(2.04atm)(6.7L)\left(\frac{1}{3.1L}\right) =$

4.4 atm

b.

$V_1 = 873$ ml $\quad T_1 = 365$ K $\quad V_2 = ?$ $\quad T_2 = 345$ K

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad V_2 = \frac{V_1T_2}{T_1}$

$873mL\left(345K\right)\left(\frac{1}{365K}\right) =$

825 mL

c.

$T_1 = 210$ K  $P_1 = 101$ kPa  $T_2 = ?$  $P_2 = 215$ kPa

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$  $T_2 = \frac{P_2 T_1}{P_1}$  $\frac{(215\ kPa)(210\ K)}{(101\ kPa)}$

447 K

16. A balloon will burst at a volume of 2.0 L. If the gas in a partially filled balloon occupies 0.75 L at a temperature of 21°C, and a pressure of 990 kPa, what is the temperature at which it will burst if the pressure is 1010 kPa at the time it breaks?

$P_1 = 990$ kPa
$V_1 = 0.75$ L
$T_1 = 294$ K
$P_2 = 1010$ kPa
$V_2 = 2.0$ L

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$  $T_2 = \frac{P_2V_2T_1}{P_1V_1}$  $(1010\ kPa)(2.0\ L)(294\ K)\left(\frac{1}{990\ kPa}\right)\left(\frac{1}{0.75\ L}\right)$

799.8 K

17. Calculate the volume a gas will occupy under the following conditions: 3.00 mol $H_2$ at 24°C and 0.98 atm.

$PV = nRT$

$V = \frac{nRT}{P}$  $(3.0\ mol)\left(\frac{0.0821\ L \cdot atm}{K \cdot mol}\right)\left(\frac{297\ K}{1}\right)\left(\frac{1}{0.98}\right) = 74.6\ L$

18. If 50 L of nitrogen are used with excess hydrogen to produce ammonia ($NH_3$), what volume of ammonia is formed at STP? At 63kPa and 32°C?

$N_2 + 3H_2 \rightarrow 2NH_3$
A  B

ATSTP $50\ L_A\left(\frac{1\ mol_A}{22.4\ L}\right)\left(\frac{2\ mol_B}{1\ mol\ A}\right)\left(\frac{22.4\ L}{1\ mol}\right) = 100\ L$

100L @ STP

$PV = nRT$  $V = \frac{nRT}{P}$

You can't do this one because you don't have moles.

19. Chlorine has a molar mass of 70.9 g/mol. What is its density at STP? What is its density at 0.87 atm and 27°C?

$D = \frac{m}{V}$  $\frac{70.9\ g}{mol} \times \frac{1\ mol}{22.4\ L} = 3.17\ g/L$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$  $V_2 = \frac{P_1V_1T_2}{T_1P_2}$  $\frac{(1\ atm)(22.4\ L)(300\ K)}{(273\ K)(0.87\ atm)}$

$\frac{70\ g}{mol} \times \frac{1\ mol}{28.3} = 2.5$

3.17 g/L @STP  2.5 g/L

20. Calculate the partial pressure of water vapor if the total pressure is 720 mmHg, nitrogen is 560 mmHg, and oxygen is 155 mmHg.

$P_T = P_{N_2} + P_{O_2} + P_{H_2O}$

$720\ mm\ Hg = 560\ mm\ Hg + 155\ mm\ Hg + X$

5 mm Hg.

21. Convert the following pressures.

a. 4.5 atm to psi

$$4.5\ \text{atm}\left(\frac{14.7\ \text{psi}}{1\ \text{atm}}\right) = 66.15\ \text{psi}$$

b. 167 kPa to mmHg

$$167\ \text{kPa}\left(\frac{760\ \text{mmHg}}{101.3\ \text{kPa}}\right) \qquad 1253\ \text{mmHg}.$$